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Demolition and construction noise

Excessive noise can damage people's health or hearing and can cause disturbance to living or working environments.
This digest describes briefly some of the legislation and codes of practice aimed at controlling the levels of noise emitted from sites, and discusses methods of estimating and reducing plant noise.

Legislation

Legislation for the protection of people and the environment against noise has recently been extended by two Acts of Parliament.

The Health and Safety at Work etc Act, 1974,[1] provides for the protection of workers against risks to their safety and health, including the risk of hearing damage. On construction and demolition sites this mostly concerns plant operators or drivers, but men working close to plant must also be considered.

The Control of Pollution Act, 1974,[2] gives local authorities powers to protect the community against noise. Under Part III of this Act, a local authority may specify its own requirements to limit noise on construction and demolition sites by serving a notice that may in particular:

a. specify the plant or machinery which is, or is not, to be used;
b. specify the hours during which the work may be carried out;
c. specify the level of noise which may be emitted from the premises in question or at any specified point on those premises or which may be so emitted during specified hours; and
d. provide for any change of circumstances.

In specifying their requirements the local authority shall have regard:

a. to the relevant provision of any code of practice issued under this Part of this Act;
b. to the need for ensuring that the best practical means are employed to minimise noise;
c. before specifying any particular methods or plant or machinery, to the desirability in the interests of any recipient of the notice in question of specifying other methods or plant or machinery which would be substantially as effective in minimising noise and more acceptable to them;
d. to the need to protect any persons in the locality in which the premises in question are situated from the effects of noise.

The Act also provides for a developer or contractor to ascertain from the local authority the noise restrictions that will apply to a contract at the same time as, or subsequent to, a request for approval under building regulations under Part II of the Public Health Act 1936, or in Scotland a warrant under Section 6 of the Building (Scotland) Act 1959.

Codes of Practice

Code of practice for reducing the exposure of employed persons to noise[3] gives recommendations for the maximum safe daily dosages of noise for the unprotected human ear. The accepted limit for an eight-hour exposure to a steady sound is 90 dB(A). If the exposure is for a period other than eight hours, or if the sound level is fluctuating (as is usually the case with building works), the equivalent continuous sound level, Leq, should not exceed 90 dB(A). Practical rules for the calculation of Leq are given in the Code. If the daily dosage exceeds the safe limits, the contractor should provide the operatives with ear protectors. Advice on the selection of protectors is also given in the Code.

British Standard 5228, Code of Practice for noise control on construction and demolition sites[4] outlines the application of The Control of Pollution Act, 1974, and considers the role of the local authority as well as that of the developer, the designer and the contractor. In setting a noise limit, a local authority may specify a permissible noise level at a point 1 m from the exterior surface of the nearest noise-sensitive building. The limit may be in terms of a maximum noise level or of an equivalent con-

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tinuous sound level, Leq, for a given period. Although the Code suggests limiting values of Leq for a 12-hour period (eg 0700 to 1900 hours), these values have no legal significance.

Planning

The developer and the designer have a part to play at the early stages of planning a project. Early consultation should be made with the local authority to ascertain the noise restrictions that will apply. The design of the whole project should then be considered so as to avoid, as far as possible, noisy processes and machines. It may also be necessary to make estimates of the total noise emission from the site to check if proposed construction methods will be acceptable.

Details of noise restrictions should be included in the tender documents, so that the tenderer can take this into account in estimating plant requirements and at the same time consider whether any special noise control measures will be needed.

A more detailed check on noise emission can be made when the contract is awarded. For example, a production programme can indicate the locations and periods of operation of plant as well as the numbers and types of machine needed, so that noise levels can be predicted and compared with the limits set. Such a prediction will be possible only if the actual noise output of each machine is known; this information is also needed to determine whether operatives should wear ear protectors. If prediction shows that infringement is likely, means for controlling the spread of noise or the use of quieter machines or methods should be considered.

The Code[4] gives detailed guidance on the prediction and monitoring of noise as well as on methods for controlling the spread of noise.

In general, an extensive knowledge of acoustics is not needed for the prediction of noise levels on construction and demolition sites; a familiarity with some of the general principles and the terminology is, however, necessary.

Noise limits and measurement

Sound is transmitted as pressure disturbances in the air which vibrate the ear drum to cause the sensation of hearing. A sound is quantified by its sound pressure level: a ratio of the pressure of the sound to a reference sound pressure, usually that of the quietest audible sound. This ratio is expressed in decibels (dB) and is measured with a sound level meter. To represent subjective reactions to noise, the dB measurements have to be modified or 'weighted' to take account of the response of the human ear which varies with the frequency of sound. This 'weighting' is achieved by setting the sound level meter to the 'A' scale; the sound level is then indicated in dB(A). A sound level is only meaningful when the location of the point of measurement is specified; for example, the noise level from a building site measured at a point 1 m outside the nearest occupied buildings, or the noise of a machine measured at a point 1·5 m above ground at a distance of 10 m.

The noise from a machine can also be expressed as a sound power level: a measure of the total sound energy emitted per unit time. For practical purposes the sound power level is calculated:

Sound power level, dB(A) =
sound level, dB(A) + 8 + 20 log R
where R is the distance in metres from the centre of the machine at which the sound level is measured.

Sound power is a measure of the noise output of a machine (or source) and is therefore not dependent on distance from the source, except that the distance should not be too small because of near field effects.

An equivalent continuous sound level (Leq) is a notional steady level which would, over a given period of time, deliver the same sound energy as an actual fluctuating sound. Instruments are available that indicate Leq directly. If Leq is calculated or measured for a period of 12 hours it is referred to as Leq (12 hr) and the value is given in dB(A).

Limitation of site noise by Leq (12 hr) permits a higher Leq for shorter periods provided the background noise during the remainder of the period is at least 10 dB(A) below the 12-hour limit. In that case an increase of 3 dB(A) can be allowed for each halving of the period. Thus, for a limit of Leq (12 hr) 75 dB(A), an Leq of 78 dB(A) would be permissible for a working period of 6 hours, or 81 dB(A) for a period of 3 hours. If it is known that a particular process will produce high noise levels for short periods, it may be more appropriate to restrict the maximum noise level rather than Leq.

Both codes[3, 4] give further information on noise units and recommendations concerning measuring instruments.

Plant noise

The main problem of noise in construction and demolition arises from the operation of plant and powered hand-tools. Some machines are already produced in a sound-reduced form and methods for obtaining greater reductions and for reducing the noise of other plant are under investigation. It remains to be seen how much noise reduction is physically and economically feasible.

In making predictions of site noise it is essential to have reliable information on the sound output of the plant that will be used. The noise produced by a machine depends on many factors such as the speed of operation and the work performed. Some manufacturers publish noise levels for their machines, but the conditions under which the noise levels were obtained are not necessarily the same for all types of plant. Standard procedures for noise tests representative of plant in operation are currently being developed by the International Organization for Standardization and the European Economic Community. The only document so far published is ISO 2151 — *Measurement of airborne noise emitted by compressor/prime-mover — units intended for outdoor use.** Some countries have already set upper limits for the noise outputs of certain types of plant: EEC Directives on this subject are also in preparation. Until standard test procedures have been adopted and the noise outputs of machines are quoted on this basis, use can be made of published figures such as those in Table 5 of BS 5228. The values in this table are maximum sound power levels taken from limited measurements on site and from various published data. In practice, values could be found which fall outside the ranges quoted. Alternatively, plant owners can make their own measurements.

In noise tests that have already taken place on plant such as excavators, loading shovels and dumpers it has often been the practice to measure noise levels at a distance of about 10 m from the centre of the machine (in standard procedures for testing it is likely that this distance will depend on the dimensions of the plant) and at a height of 1·5 m above ground. Measurements are necessary on four sides of a machine and, perhaps, at points above the machine as well, because differences can occur, due for example, to the position of the engine or the exhaust.

There can be considerable variation in the noise output of a machine during working. Measurements 10 m from a mobile crane, for example, gave levels of: 87 dB(A) hoisting; 83 dB(A) slewing; and 73 dB(A) engine idling.

Estimating noise emissions from sites

If the noise outputs of the machine to be used are known and production has been planned so that the locations of the machines and their periods of operation can be forecast, the resultant maximum noise level can be estimated at a point outside the site where a maximum noise limit may be specified.

In theory, and under specific conditions, the level of sound from a point source of noise is reduced by 6 dB(A) when the distance from the source is doubled. Although construction machines cannot be regarded as point sources of noise and conditions on sites vary considerably from those on which the theory is based, site studies[5] have shown that this figure can be used to give sufficiently accurate estimates of distance attenuation in practice.

If the noise output of a machine is given as a noise level measured at a radius x from the centre of the machine, the reduction in this noise level at a greater radius y is equal to $20 \log_{10} \frac{y}{x}$.

If, however, the noise output of a machine is given in terms of sound power level, the noise level at any radius up to 700 m from the centre of the machine can be quickly obtained from the graph, Fig 1. For example, if the sound power level of a machine is 120 dB(A), the noise level at a radius of 30 m is $120 - 37 = 83$ dB(A).

Often several machines will be operated simultaneously and the total noise at a point where a maximum noise limit applies has to be estimated. The first step is to determine the noise level of each machine separately at that point. The following table then shows how to predict the total effect of two sound levels:

Difference between the two sound levels *dB(A)*	**Amount to be added to the higher sound level to obtain the total sound level** *dB(A)*
0 to 1	3
2 to 3	2
4 to 9	1
10 and above	0

If four machines individually produce noise levels of 70, 75, 76 and 77 dB(A) the total noise is obtained by combining the levels in pairs as follows:

70 and 75 dB(A), combined level is 75 + 1 = 76 dB(A)
76 and 76 dB(A), combined level is 76 + 3 = 79 dB(A)
79 and 77 dB(A), combined level is 79 + 2 = 81 dB(A)

Thus the total noise from the four machines is 81 dB(A).

When estimating the noise level at the façade of a building, the Code[4] recommends that an addition of 3 dB(A) should be made to the levels calculated to allow for the effect of reflection. Where multiple reflections occur, due for example to a recess in a building, sound levels may be increased even further.

The estimation of site noise emission in terms of an equivalent continuous sound level (Leq) is more complex because a more precise forecast of the overall working time of each machine is necessary as well as the fluctuations in level that occur during

*Available in UK from British Standards Institution, 2 Park Street, London W1A 2BS.

the working cycle of the machine. The Code[4] deals with methods of calculation in estimating Leq and gives examples of their use. As yet, however, there is no published information on practical experience in the use of Leq for the control of noise from construction and demolition sites.

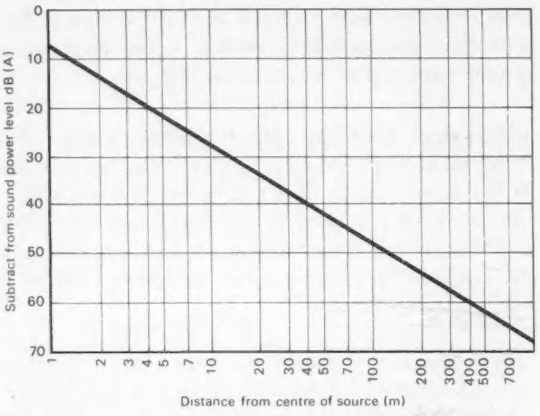

Fig 1 Amount to be subtracted from sound power level to determine the sound level at some distance from the source

Note Sound levels determined by reference to this graph are unreliable at distances less than 3 major dimensions of the source or if the source radiates sound in a marked directional manner

Reducing noise emission

When estimates of site noise emission show that infringement of a noise limit is likely, or when an infringement has occurred, one or several of the following means for reducing noise should be considered:

Siting of plant

By siting plant or operations as far as possible from a noise-sensitive area, or so that mounds of earth, stacks of materials or buildings on site reduce the transmission of sound.

By positioning a machine so that the quietest side faces the noise-sensitive area.

Operation of plant

By operation at a low speed.

By shutting down when not in use.

By keeping engine or machinery covers closed.

By reducing the number of machines in simultaneous operation.

By regular maintenance, notably to avoid rattling noises due to loose fixings or frictional noises due to lack of lubrication and to keep exhaust systems in good order.

Alternative plant or method

By using noise-reduced plant or by modifying the construction method so that noisy plant is unnecessary.

Screening

By erecting a noise barrier between the source of noise and the noise sensitive area (suitable for mobile plant).

By providing an acoustic enclosure for a machine, paying due regard to cooling and ventilation (suitable for a static machine).

By using an acoustic shed in which, for example, a man can work with a concrete-breaker. The operator is then exposed to a greater risk of hearing damage and should wear ear-protectors.

References

1 The Health and Safety at Work etc. Act, chapter 37, HMSO
2 The Control of Pollution Act 1974, chapter 40, HMSO
3 Department of Employment Code of practice for reducing the exposure of employed persons to noise, HMSO
4 BS 5228, Code of Practice for noise control on construction and demolition sites, British Standards Institution
5 Construction site noise, BRE Current Paper CP 57/75

Further reading

Thermic boring, BRE Current Paper CP 58/75
The Nibbler: a new concept in concrete breaking, BRE Current Paper CP 83/74

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